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⑦③ Proprietor: **PRODUCT RESEARCH & DEVELOPMENT**  
**12650 Westminster Avenue**  
**Santa Ana California 92706-2100 (US)**

⑦② Inventor: **Solomon, Donald F.**  
**25666 Mosport Street**  
**Hemet, California 92344 (US)**

⑦④ Representative: **Enskat, Michael Antony Frank**  
**et al**  
**Saunders & Dolleymore 9, Rickmansworth**  
**Road**  
**Watford Hertfordshire WD1 7HE (GB)**

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## Description

This invention relates to an improved reverse osmosis system.

Reverse osmosis systems are commonly used for removing impurities from water, such as drinking water. A conventional reverse osmosis system includes a reverse osmosis filter having a reverse osmosis membrane. Feed water is supplied to the filter, and the filter delivers filtered product water having a reduced impurity content. Not all of the feed water supplied to the filter passes through the reverse osmosis membrane, and this unfiltered water, or brine, can be discharged to drain or a portion of it can be recycled through the filter.

To increase the throughput, i.e., the volume of product water, it is known to employ a pump to increase the pressure of the feed water supplied to the reverse osmosis filter. A conventional electric motor driven pump is used for this purpose. Motor driven pumps increase installation costs by requiring electrical wiring to the pump. In addition, they are subject to higher operational costs due to the cost of electricity and the cost of maintaining and repairing or replacing the electrical motor.

EP-A-314 374 describes a reverse osmosis system including a reverse osmosis filter having a reverse osmosis membrane, an inlet port, a product water outlet port for filtered product water and a brine outlet port for brine and a pump including a housing having a cavity, a feed water inlet port communicable with a source of feed water, an outlet port communicable with the inlet port of the filter, a piston reciprocable in the cavity and dividing the cavity into a feed water inlet chamber communicable with the feed water inlet port of the housing, an outlet chamber communicating with the outlet port of the housing and a reversing chamber and conduit means coupling the brine outlet port of the filter to the reversing chamber and to drain and wherein the piston is movable on a pumping stroke to increase the pressure of the feed water and on a return stroke without increasing the pressure of the feed water.

In the system of EP-A-314 374, a restricted orifice is provided in the conduit leading to drain. With this construction, the reversing chamber is always in communication with drain through the restricted orifice.

In the invention, the restricted orifice is eliminated and in addition, the brine valve blocks the flow of brine from the reverse osmosis filter to drain during the return stroke of the pump. With this construction, the brine valve also allows the flow of brine from the pump to drain during the pumping stroke. More specifically, during the pumping stroke, the brine valve allows flow from the reversing chamber to the drain port and blocks flow from the brine inlet port to the drain port and to the reversing chamber. During the

return stroke, the brine valve blocks flow from the reversing chamber to the drain port and allows flow from the brine inlet port to the reversing chamber. This improvement has the advantage of preventing loss of water during the return stroke because, during that time, the brine valve prevents the flow of brine from the reversing chamber to drain. This keeps the ratio of brine to product water relatively constant.

The invention, together with additional features and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying illustrative drawings.

Fig. 1 is a schematic view partially in section illustrating the prior art reverse osmosis system known from EP-A-314 374. The piston shown at the beginning of the pumping stroke.

Fig. 2 is a fragmentary sectional view showing a portion of Fig. 1, with the piston at the end of its pumping stroke.

Fig. 3 is a view similar to Fig. 1 illustrating a reverse osmosis system and pump in accordance with the invention, with the piston being illustrated at the beginning of the pumping stroke.

Fig. 4 is an enlarged, fragmentary sectional view illustrating the brine valve and the adjacent structure.

Fig. 5 is a view similar to Fig. 2 showing the reverse osmosis system of the invention with the piston at the end of its pumping stroke.

Fig. 6 is a view similar to Fig. 4 illustrating the position of the brine valve when the piston is at the end of the pumping stroke.

Figs. 1 and 2 of the drawings show a prior art reverse osmosis system 11 which comprises a reverse osmosis filter 13 and a pump 15. The reverse osmosis system 11 is as described in EP-A-314 374 and includes a reverse osmosis membrane 17 within a housing 19. The housing 19 has an inlet port 21, a product water outlet port 23 and a brine outlet port 25.

The pump 15 includes a housing 27 having a feed water inlet port 29, a feed water outlet port 31, brine inlet port 33, a brine outlet port 35 and a drain or reversing port 37. The inlet port 29 is coupled to a source 39, such as a pump and/or a city water supply, of feed water under pressure by a conduit 41, and the outlet port 31 is coupled by a conduit 43 to the inlet port 21 of the filter 13. Together, the conduits 41 and 43 constitute an inlet conduit which extends between the source 39 of feed water and the inlet port 21 of the filter.

A conduit 44 joins the brine outlet port 25 with the brine inlet port 33. A conduit 45 joins the brine outlet port 35 with the drain port 37. A drain conduit 47 extends from the conduit 45 to drain. A restricted orifice 49 is provided in the drain conduit 47.

Although various constructions are possible, in the system shown, the housing 27 includes a main body 51, an end section 53 containing the port 31 and attached to the main body by a retaining ring 55 and

an end section 57 containing the ports 33 and 35 and suitably attached to the other end of the main body 51 in any suitable manner. The end section 53 has a sleeve portion 59. The interior of the housing 27 is hollow, and a partition 61 is retained between the main body 51 and the end section 57 and divides the interior of the housing into cavities 63 and 65 on opposite sides of the partition.

A piston 67 is reciprocable in the cavity 63, and divides the cavity into an inlet chamber 69 communicating with the inlet port 29, an outlet chamber 71 communicating with the outlet port 31, and a reversing chamber 73 communicating with the drain port 37. The piston 67 is a differential area piston and has a relatively large area face 75 in the inlet chamber 69 and a smaller area face 77 in the outlet chamber 71. The piston 67 also has a reversing face 78 in the reversing chamber 73. The faces 75 and 78 are on an enlarged head 79 that sealingly slides along the peripheral wall of the inlet chamber 69 and the reversing chamber 73. The face 77 is provided, in this embodiment, as an end face of a tubular stem 81 which is sealingly slidable within the sleeve portion 59 of the end section 53. The main body 51, the sleeve portion 59 and the stem 81 are preferably coaxial. The stem 81 has an annular internal shoulder 83 adjacent the face 77. A shoulder 85 is adjacent the face 75 and, in this embodiment, is provided by an end surface of a snap ring carried by the piston 67. A coil compression spring 87 acts between the end section 53 and the head 79 of the piston 67 to urge the piston downwardly as viewed in the drawing.

A check valve 89 is carried by the piston 67 at the face 77. The stem 81 has a passage 91 extending through it, and the check valve 89 closes and opens the upper (as viewed in the drawing) end of the passage 91. The check valve 89 may be of any kind which will open when the pressure in the passage 91 is greater than the pressure in the outlet chamber 71. In the system illustrated, the check valve 89 comprises an open cage suitably attached to the stem 81 at the face 77 and a resilient valve element 95 loosely axially retained within the cage and on the face 77. Accordingly, when the fluid pressure in the passage 91 exceeds the fluid pressure in the outlet chamber 71, the fluid pressure in the passage 91 forces the valve element 95 upwardly as viewed in the drawing to allow fluid flow from the passage 91 to the outlet chamber 71. Conversely, when the pressure differential across the valve element is reversed, the valve element 95 is seated tightly against the face 77 to preclude flow between the outlet chamber 71 and the passage 91.

A brine valve 97 controls the flow of brine from the brine inlet port 33 to the brine outlet port 35. Although the brine valve 97 may be remote from the piston 67, in this system they are closely adjacent and within the same housing. The brine valve 97 also performs a control function for the pump 15 and, there-

fore, may be considered as part of the pump and within the pump housing even if it is located remotely from the piston 67.

The brine valve 97 includes a valve element 99 and a valve seat 101 of a soft, compliant material on the end section 57 of the housing 27. The valve element 99 is movable between a closed position shown in the drawing in which the valve element 99 seats on the valve seat 101 and an open position in which the valve element 99 is moved upwardly as shown in the drawing and is axially spaced from the valve seat 101 to thereby allow the flow of brine from the brine inlet port 33 to the brine outlet port 35. The valve element 99 cooperates with the housing to define a valve chamber 102 above (as viewed in Fig. 1) the valve element. A bleed passage 103 between the valve element 99 and the partition 61 allows for the flow of brine from the brine inlet port 33 into the chamber 102. Thus, the valve element 99 has a face in the chamber 102 which is exposed to brine at brine pressure and an opposite face which is exposed to fluid at drain pressure existing in the conduit 45.

The brine valve 97 is opened and closed by movement of the piston 67, and for this purpose, the brine valve and the piston are resiliently drivingly coupled together. Although this can be accomplished in different ways, in this system the connection is provided by a rod 105 coupled to the valve element 99 and extending in sealed relationship through a bore of the partition 61 into the passage 91. The coupling means also includes collars 107 and 109 slidable on the rod 105 between retaining rings 111 and 113, which are fixed on the rod 105, and a coil compression spring 115 between the collars and resiliently urging the collars away from each other. The coupling means also includes the shoulders 83 and 85.

To start up the system 11, it is only necessary to turn on the source 39 of feed water under pressure, and this can be done, for example, by opening an appropriate valve or water tap and/or turning on a pump (not shown). Of course, as is common for virtually all liquid-operated devices, it would be desirable to first bleed air from the system so that all appropriate lines and components are filled with water. Although air-bleeding techniques are well known, by way of example, the feed water from the source 39 could be turned on with the conduit 44 partly decoupled from the brine inlet port 33 to allow water to flow through and fill the chamber 71, the conduits 43 and 44 and the filter 13.

In use, feed water is supplied from the source 39 through the conduit 41 and the feed water inlet port 29 to the inlet chamber 69. As shown in the drawing, the piston 67 is at the lowermost position, and water at drain pressure acts in the reversing chamber 73 against the face 78 of the piston in conjunction with the spring 87 to tend to hold the piston in this lowermost position. Assuming that the outlet chamber 71 is charged with feed water, the feed water at inlet

pressure acting over the relatively large face 75 is sufficient to move the piston 67 on a pumping stroke (upwardly as viewed in the drawing) to pressurize the water in the outlet chamber 71 and to force the pressurized feed water through the conduit 43 to the inlet port 21 of the filter 13. In so doing, the pump 15 boosts the pressure of the water at the source 39 to a higher pressure and delivers it to the filter 13. During the pumping stroke of the piston 67, the brine valve 97 remains closed due to the differential fluid pressure acting across the valve element 99 and the pressure on the upper end of the rod, and initially the spring 115 is compressed between the collars 107 and 109 to further urge the valve 97 toward the closed position. However, the spring 115 expands to move the collar 107 into engagement with the ring 111 as the pumping stroke progresses.

The reverse osmosis membrane 17 removes impurities from the water supplied to the filter 13 and delivers it to the outlet port 23 as filtered product water. Because the brine valve 97 is closed, no brine can flow from the filter 13 to drain, and consequently, the piston 67 moves on the pumping stroke to provide make up feed water at the same rate that product water is discharged at the outlet port 23.

As the piston 67 nears the end of the pumping stroke, i.e., approaches the position of Fig. 2, the shoulder 85 engages the collar 109 to compress the spring 115. This exerts an upward force on the valve element 99 and when this upward force is sufficient to overcome the valve closing force resulting from the differential pressure acting across the valve element 99, the valve element 99 is lifted off the seat 101 and is driven by the spring 115 to the fully open position after termination of the pumping stroke.

In any event, with the brine valve 97 open, brine can now flow through the conduit 44, the brine inlet port 33, the brine outlet port 35 and the conduit 45 to both the reversing chamber 73 and the orifice 49. Although the conduit 45 is open to drain via the conduit 47, the presence of the restricted orifice 49 in the conduit 47 prevents the pressure in the conduit 45 and the pressure within the reversing chamber 73 from dropping all the way to drain pressure, which may be essentially zero psig. Consequently, there is a significant pressure increase in the reversing chamber 73, and this pressure acts across the relatively large area face 78. In addition, the opening of the brine valve 97 reduces the pressure in the filter 13, the conduit 43 and the outlet chamber 71 to less than the pressure of the feed water in the inlet chamber 69. Consequently, the differential pressure acting across the check valve 89 lifts the valve element 95 to allow water to flow from the inlet chamber 69 to the outlet chamber 71. During the return stroke, the check valve 89 is held open by feed water pressure because the brine valve 97 is open so the chamber 71 communicates with drain pressure.

The effect of this is twofold. First, the opening of the check valve 89 places the face 77 essentially at the pressure of the feed water from the source 39, and this is a pressure increase relative to the pressure which existed in the outlet chamber 71 immediately prior to opening of the check valve 89. Accordingly, the increased pressure in the outlet chamber 71 and the reversing chamber 73 in conjunction with the force of the spring 87 are sufficient to move the piston 67 downwardly on its return stroke against the force of the feed water acting against the face 75.

Secondly, the opening of the check valve 89 enables the outlet chamber 71 to be recharged with feed water on the return stroke. Consequently, on the next pumping stroke, the outlet chamber 71 is charged with water which can be delivered at boosted pressure to the filter 13.

During the return stroke of the piston 67, water that cannot be contained in the chamber 71 is flushed through the filter 13 with an advantageous flushing action on the membrane 17. This is possible because, during the return stroke, the brine valve 97 is open (Fig. 2) so that there is an open flow path between the chamber 71 and the orifice 49 (Fig. 1) which leads to drain.

As the piston 67 nears the end of the return stroke, the shoulder 83 contacts the collar 107 and compresses the spring 115 to thereby provide a resilient closing force on the valve element 99. When the spring is compressed sufficiently, it generates an adequate closing force to move the valve element 99 downwardly into sealing engagement with the seat 101 to thereby close the brine valve 97. However, the spring 115 closes the valve 97 after termination of the pumping stroke. This restores the conditions which existed at the beginning of the first pumping stroke described above so that the operation can be repeated.

From the foregoing, it is apparent that movement of the piston 67 is used to open and close the brine valve 97. Also, opening of the brine valve 97 brings about termination of the pumping stroke, and closing of the brine valve 97 brings about termination of the return stroke. Reversal of movement of the piston 67 at the end of the pumping stroke is brought about by increasing the pressure within the cavity 63 and chamber 71.

The valve chamber 102 and the bleed passage 103 act like a dashpot to retard movement of the valve element 99 toward either the open or closed position. This relatively slower movement of the valve element 99 in conjunction with the spring 115 assures that the piston 67 will complete its stroke before movement of the valve element 99 is completed.

During the return stroke, feed water at boosted pressure is no longer being supplied to the filter 13. Consequently, the length of time to accomplish the return stroke and to reseal or close the brine valve 97

should be minimized. With this invention, the forces acting on the piston 67 as described above enable the return stroke to be accomplished in a minimum length of time, such as, for example, 1.5 to 2 seconds. By way of example, the pumping stroke may last 1.5 minutes, and in this event, the portion of the cycle time devoted to the return stroke and to closing of the brine valve 97 is minimal.

Figs. 3-6 show a system 11a in accordance with the invention which is identical to the prior art system 11 in all respects not shown or described herein. Portions of the system 11a corresponding to portions of the system 11 are designated by corresponding reference numerals followed by the letter "a".

The primary differences between the systems 11a and 11 is that the former does not have the restricted orifice 49, and the brine valve 97a controls flow among the brine port 33a, the drain port 37a and a reversing chamber port 201. In addition, the dashpot, i.e., the cavity 65 and the bleed passage 103 of the system 11 are eliminated in the system 11a, and the spring 115a is retained in a different manner.

Functionally, the primary difference between the systems 11a and 11 is that the brine valve 97a blocks flow of brine from the reversing chamber 73a to the drain port 37a during the return stroke of the piston 67a.

The brine valve 97a has a valve element 99a coupled to the rod 105a and movable therewith between the position of Figs. 3 and 4 and the position of Figs. 5 and 6. The valve element 99a has a passage 204 extending therethrough and is movable in a mounting member 203 which is suitably retained within the housing 27a. As shown in Fig. 3, the housing 27a may comprise housing sections 205 and 207 held together by fasteners (not shown), with the mounting member 203 captured between the housing sections. Annular seals 209, 211, 213 and 214 seal between surfaces as shown in Fig. 3. Annular, resilient valve seats 215 and 216 are retained between the mounting member 203 and the housing section 205.

The brine port 33a and the reversing chamber port 201 lead to chambers 217 and 219, respectively, and the drain port 37a leads to a drain at essentially zero pressure and to a chamber 221 above the valve seat 215. With the brine valve 97a in the position shown in Figs. 3 and 4, the lower end of the valve element 99a engages the valve seat 216 to block communication between the chambers 217 and 219 so that the brine port 33a does not communicate with either of the ports 37a or 201. However, the valve element 99a is spaced from the valve seat 215 to provide communication between the ports 37a and 201 via openings 220 and 220' and the chamber 219 as best shown in Fig. 4.

With the brine valve 97a in the position shown in Figs. 5 and 6, the valve element 99a is spaced from the valve seat 216 to provide communication be-

tween the brine port 33a and the reversing chamber port 201 via the chamber 217, the passage 204 in the valve element 99a, the chamber 219 and the opening 220 leading to the port 201. In addition, the valve element 99a engages the valve seat 215 to block communication between the drain port 37a and both of the ports 33a and 201.

As shown in Figs. 3 and 5, the reversing chamber port 201 is coupled via a conduit 223 to another reversing chamber port 225, which leads directly into the reversing chamber 73a. Although the ports 201 and 205 may be separate ports interconnected by a conduit as shown in the drawings, obviously the port 201 may lead directly into the reversing chamber 73a, and so functionally, the ports 201 and 225 and the conduit 223 simply serve to communicate the reversing chamber 73a with the brine valve 97a.

In this system, the spring 115a is retained farther down on the piston 67a, and for this purpose, the shoulder 83a is relatively farther down on the piston than is the shoulder 83. In addition, the collar 109a is retained on an integral shoulder on the rod 105a.

The system 11a also includes a check valve 231 in the pump 15a adjacent the inlet port 29 or in the conduit 41a between the source 39a and the pump. The check valve 231 allows flow from the source 39a to the pump 15a and prevents flow in the reverse direction. The check valve prevents the high pressure existing in the inlet chamber 69a during the return stroke from backflowing toward the source 39a, which may be a city water line.

Also, an accumulator 233 may be provided between the feed water outlet port 31a and the inlet port 21a of the filter 13a. The accumulator 233, which may be of conventional construction, allows the water under pressure from the outlet port 31a of the pump 15a to compress air in the accumulator in a known manner to thereby store energy in the compressed gas. During the return stroke, the accumulator 233 releases some of the stored energy to help maintain pressure at the filter 13 somewhat higher during the return stroke.

The operation of the system 11a is essentially identical to the operation of the system 11, except that the brine valve 97a blocks flow of brine from the reversing chamber 73a to the drain port 37a throughout the return stroke whereas, in the system of Figs. 1-2, some brine could flow to drain through the restricted orifice 49 during the return stroke. Also, the system 11a does not have a dashpot associated with the brine valve 97a, and so the function described above for the cavity 65 and the bleed passage 103 are not present in the system 11a. In other respects, the operation of the system 11a is essentially the same as the operation of the system 11.

Briefly, during the pumping stroke, the reversing chamber 73a is at atmospheric or drain pressure because it communicates with the drain port 37a while

th pressure in the outlet chamber 71a is high because it is multiplied by the differential area piston 67a. Also during the pumping stroke, water from the outlet chamber 71a is forced under high pressure to and through the membrane 17a as the liquid in the reversing chamber 73a is dumped to drain, and water from the source 39a enters the inlet chamber 69a. Also, the spring is compressed. During the return stroke, the system is shut off from the drain 37a, and essentially the same high fluid pressure exists in the outlet chamber 71a, the reversing chamber 73a and the inlet chamber 69a. The energy stored in the spring 87a moves the piston 67a on the return stroke, and the water from the inlet chamber 69a moves through the check valve 89a and flows to the filter 13a to provide a flushing action through the filter and the membrane 17a. From there, the water moves to the reversing chamber 73a through the valve 99a and the conduit 223.

Of course, the brine valve 97a need not be in the housing 27a as it is only necessary that the brine valve be able to control flow from the brine outlet port 25a to the reversing chamber 73a and from the reversing chamber to drain. Although a single brine valve can accomplish these flow control functions most efficiently, the brine valve may include multiple valves, if desired.

Although an exemplary embodiment of the invention has been shown and described, many changes, modifications and substitutions may be made by one having ordinary skill in the art within the scope of the invention as defined by the following claims.

#### Claims

1. A reverse osmosis system (11a) including a reverse osmosis filter (13a) having a reverse osmosis membrane (17a), an inlet port (21a), a product water outlet port (23a) for filtered product water and a brine outlet port (25a) for brine and a pump (15a) including a housing (27a) having a cavity, a feed water inlet port (29a) communicable with a source (39a) of feed water, an outlet port (31a) communicable with the inlet port (21a) of the filter (13a), a piston (67a) reciprocable in the cavity and dividing the cavity into a feed water inlet chamber (69a) communicating with the feed water inlet port (29a) of the housing, an outlet chamber (71a) communicating with the outlet port (31a) of the housing and a reversing chamber (73a) and conduit means (217, 219, 37a, 221, 223, 225) coupling the brine outlet port (25a) of the filter to the reversing chamber (73a) and to drain and wherein the piston (67a) is movable on a pumping stroke to increase the pressure of the feed water and on a return stroke without increasing the pressure of the feed water, characterized

in that

- a valve (97a) is provided in the conduit means (217, 219, 37a, 221, 223, 225) for blocking the flow of brine from the reversing chamber (73a) to drain during the return stroke and allowing the flow of brine from the brine port (25a) of the filter to the reversing chamber (73a) during the return stroke.
2. A system as defined in Claim 1 wherein the valve (97a) allows the flow of brine from the reversing chamber (73a) to drain during the pumping stroke.
3. A system as defined in Claims 1 or 2 wherein the valve (97a) is carried by said housing (27a).
4. A system as defined in Claims 1, 2 or 3 wherein the housing (27a) has a brine inlet port (33a) and a drain port (37a) forming a portion of said conduit means and the valve (97a) controls communication among the brine inlet port (33a), the drain port (37a) and the reversing chamber (73a) to allow flow from the reversing chamber to the drain port (37a) and to block communication between the brine inlet port (33a) and the drain port (37a) during the pumping stroke and to block flow from the reversing chamber (73a) to the drain port (37a) and to allow flow from the brine inlet port (33a) to the reversing chamber (73a) during the return stroke.
5. A system as defined in claims 1, 2, 3 or 4 including means for changing the position of the valve (97a) and means (83a, 85a, 109a, 115a) responsive to a change of position of the valve for reversing the direction of movement of the piston (67a).
6. A system as defined in claim 5 wherein said means (83a, 85a, 109a, 115a) for changing the position of the valve (97a) includes means (115a) for resiliently drivingly coupling the valve and the piston (67a).
7. A system as defined in claim 1 wherein the housing (27a) has first (201), second (33a) and third (37a) ports, said piston (67a) has a first relatively large area face in said inlet chamber (69a), a second smaller area face in the outlet chamber (71a) and a reversing face in the reversing chamber (73a), means (89a) for providing communication between said inlet chamber (69a) and said outlet chamber (71a) during the return stroke, said housing (27a) having a second cavity therein sealed from said inlet chamber (69a) and communicating with said first (201), second (33a) and third (37a) ports said valve (97a) is in said second

cavity and provides communication between the first (201) and third (37a) ports and blocks communication between the second (33a) and third (37a) ports during the pumping stroke and provides communication between the first (201) and second (33a) ports and blocks communication between the first (201) and third (37a) ports during the return stroke, and means (83a, 85a, 109a, 115a) responsive to movement of said piston (67a) for operating said valve (97a).

8. A system as defined in claim 7 wherein said means (89a) for providing communication includes a check valve (89a) carried by the piston (67a) and openable on the return stroke to allow fluid from the inlet chamber (69a) to enter the outlet chamber (71a) to thereby recharge the outlet chamber with fluid.
9. A system as defined in claims 7 or 8 wherein said means (83a, 85a, 109a, 115a) for operating the valve (97a) includes resilient means (115a) for coupling the valve to the piston (67a).

#### Patentansprüche

1. Umkehrosmosesystem (11a), mit einem Umkehrosmosefilter (13a), das eine Umkehrosmembran (17a), eine Einlaßöffnung (21a), eine Filtratauslaßöffnung (23a) für das erzeugte filtrierte Wasser und eine Sumpflösungsauslaßöffnung (25a) für die Sumpflösung aufweist, und mit einer fluidbetriebenen Pumpe (15a), die ein Gehäuse (27a) mit einem Hohlraum, eine Speisewassereinlaßöffnung (29a), die mit einer Speisewasserzufuhr (39a) verbindbar ist, eine Auslaßöffnung (31a), die mit der Einlaßöffnung (21a) des Filters (13a) verbindbar ist, einen Kolben (67a), der im Hohlraum hin und her bewegbar ist und den Hohlraum in eine Speisewassereinlaßkammer (69a), die mit der Speisewassereinlaßöffnung (29) des Gehäuses in Verbindung steht, eine Auslaßkammer (71a), die mit der Auslaßöffnung (31a) des Gehäuses in Verbindung steht, und eine wechselseitig wirkende Kammer (73a) unterteilt, und eine Leitungsvorrichtung (217, 219, 37a, 221, 223, 225), die die Sumpflösungsauslaßöffnung (25a) des Filters mit der wechselseitig wirkenden Kammer (73a) und mit dem Abfluß verbindet, besitzt, und wobei der Kolben (67a) bei einem Pumpenhub unter Erhöhung des Druckes des Speisewassers und bei einem Rückhub ohne Erhöhung des Drucks des Speisewassers beweglich ist, dadurch gekennzeichnet, daß in der Leitungsvorrichtung (217, 219, 37a, 221, 225) ein Ventil (97a) zum Verhindern eines Stromes von Sumpflösung aus der wechsel-

seitig wirkenden Kammer (73a) zum Abfluß während des Rückhubs und zum Ermöglichen eines Stromes von Sumpflösung von der Sumpflösungsöffnung (25a) des Filters zur wechselseitig wirkenden Kammer (73a) während des Rückhubs vorgesehen ist.

2. System nach Anspruch 1, dadurch gekennzeichnet, daß das Ventil (97a) das Strömen von Sumpflösung aus der wechselseitig wirkenden Kammer (73a) zum Abfluß während des Pumpenhubes ermöglicht.
3. System nach einem der Ansprüche 1 oder 2, dadurch gekennzeichnet, daß das Ventil (97a) vom Gehäuse (27a) gehalten ist.
4. System nach einem der Ansprüche 1, 2 oder 3, dadurch gekennzeichnet, daß das Gehäuse (27a) eine Sumpflösungseinlaßöffnung (33a) und eine Abflußöffnung (37a), die einen Teil der Leitungsvorrichtung bildet, besitzt, und daß das Ventil (97a) die Verbindung zwischen der Sumpflösungseinlaßöffnung (33a), der Abflußöffnung (37a) und der wechselseitig wirkenden Kammer (73a) steuert, um während des Pumpenhubes ein Strömen aus der wechselseitig wirkenden Kammer (73a) zur Abflußöffnung (37a) zu ermöglichen und die Verbindung zwischen der Sumpflösungseinlaßöffnung (33a) und der Abflußöffnung (37a) zu verhindern und um während des Rückhubs ein Strömen aus der wechselseitig wirkenden Kammer (73a) zur Abflußöffnung (37a) zu verhindern und ein Strömen von der Sumpflösungseinlaßöffnung (33a) zur wechselseitig wirkenden Kammer (73a) zu ermöglichen.
5. System nach einem der Ansprüche 1, 2, 3 oder 4, dadurch gekennzeichnet, daß es eine Vorrichtung zur Änderung der Position des Ventils (97a) und eine Vorrichtung (83a, 85a, 109a, 115a), die auf eine Änderung der Stellung des Ventils reagiert, um die Bewegungsrichtung des Kolbens (67a) umzukehren, aufweist.
6. System nach Anspruch 5, dadurch gekennzeichnet, daß die Vorrichtung (83a, 85a, 109a, 115a) zur Änderung der Stellung des Ventils (97a) eine Einrichtung (115a) aufweist, die das Ventil und den Kolben (67a) elastisch antreibend miteinander verbindet.
7. System nach Anspruch 1, dadurch gekennzeichnet, daß das Gehäuse (27a) eine erste (102), zweite (33a) und dritte (37a) Öffnung aufweist, daß der Kolben (67a) eine erste relativ großflächige Stirn in der Einlaßkammer (67a), eine zweite kleinerflächige Stirn in der Auslaßkammer



(71a) und ein wechselseitig wirkende Stirn in der wechselseitig wirkenden Kammer (73a) besitzt, daß eine Vorrichtung (89a) zum Schaffen einer Verbindung zwischen der Einlaßkammer (69a) und der Auslaßkammer (71a) während des Rückhubs vorgesehen ist, daß das Gehäuse (27a) einen zweiten Hohlraum aufweist, der gegenüber der Einlaßkammer (69a) abgedichtet ist und mit der ersten (201), zweiten (33a) und dritten (37a) Öffnung in Verbindung steht, daß das Ventil (97a) sich im zweiten Hohlraum befindet und während des Pumpzugs eine Verbindung zwischen der ersten (201) und dritten (37a) Öffnung schafft und eine Verbindung zwischen der zweiten (33a) und dritten (37a) Öffnung verhindert und während des Rückhubs eine Verbindung zwischen der ersten (201) und der zweiten (33a) Öffnung schafft und eine Verbindung zwischen der ersten (201) und dritten (37a) Öffnung verhindert, und daß eine Vorrichtung (83a, 85a, 109a, 115a) vorgesehen ist, die auf die Bewegung des Kolbens (67a) reagiert, um das Ventil (97a) zu betätigen.

8. System nach Anspruch 7, dadurch gekennzeichnet, daß die Vorrichtung (89a), die die Verbindung schafft, ein Rückschlagventil (89a) aufweist, das vom Kolben (67a) gehalten und beim Rückhub öffnbar ist, damit das Fluid aus der Einlaßkammer (69a) in die Auslaßkammer (71a) einströmen kann, um dadurch die Auslaßkammer wieder mit Fluid zu füllen.
9. System nach Anspruch 7 oder 8, dadurch gekennzeichnet, daß die Vorrichtung (83a, 85a, 109a, 115a) zum Betätigen des Ventils (97a) eine elastische Einrichtung (115a) aufweist, die das Ventil mit dem Kolben (67a) verbindet.

#### Revendications

1. Système d'osmose inverse (11a) incluant un filtre d'osmose inverse (13a) comportant une membrane d'osmose inverse (17a), un passage d'entrée (21a), un passage de sortie (23a) d'eau produite pour l'eau filtrée produite et un passage de sortie (25a) de saumure pour de la saumure, et une pompe (15a) incluant un carter (27a) comportant une cavité, un passage d'entrée (29a) d'eau d'alimentation pouvant communiquer avec une source (39a) d'eau d'alimentation, un passage de sortie (31a) pouvant communiquer avec le passage d'entrée (21a) du filtre (13a), un piston (67a) susceptible de se déplacer en va-et-vient dans la cavité et divisant la cavité en une chambre d'entrée (69a) d'eau d'alimentation communiquant avec le passage d'entrée (29a)

d'au d'alimentation du carter, une chambre de sortie (71a) communiquant avec le passage de sortie (31a) du carter et une chambre d'inversion (73a), et un moyen de conduit (217, 219, 37a, 221, 223, 225) reliant le passage de sortie (25a) de saumure du filtre à la chambre d'inversion (73a) et à un drain, et dans lequel le piston (67a) peut se déplacer selon une course de pompage afin d'augmenter la pression de l'eau d'alimentation, et selon une course de retour sans augmenter la pression de l'eau d'alimentation, caractérisé en ce que une vanne (97a) est disposée dans le moyen de conduit (217, 219, 37a, 221, 223, 225) pour bloquer l'écoulement de saumure depuis la chambre d'inversion (73a) vers le drain pendant la course de retour, et permettre l'écoulement de saumure depuis le passage de saumure (25a) du filtre vers la chambre d'inversion (73a) pendant la course de retour.

2. Système selon la revendication 1, dans lequel la vanne (97a) permet l'écoulement de la saumure depuis la chambre d'inversion (73a) vers le drain pendant la course de pompage.
3. Système selon l'une des revendications 1 ou 2, dans lequel la vanne (97a) est portée par ledit carter (27a).
4. Système selon la revendication 1, 2 ou 3, dans lequel le carter (27a) comporte un passage d'entrée (33a) de saumure et un passage de drain (37a) formant une partie dudit moyen de conduite, et la vanne (97a) commande la communication entre le passage d'entrée (33a) de saumure, le passage de drain (37a) et la chambre d'inversion (73a), pour permettre un écoulement depuis la chambre d'inversion vers le passage de drain (37a) et pour bloquer la communication entre le passage d'entrée (33a) de saumure et le passage de drain (37a) pendant la course de pompage, et pour bloquer l'écoulement depuis la chambre d'inversion (73a) vers le passage de drain (37a) et permettre l'écoulement depuis le passage d'entrée (33a) de saumure vers la chambre d'inversion (73a) pendant la course de retour.
5. Système selon l'une des revendications 1, 2, 3 ou 4, incluant un moyen de modification de la position de la vanne (97a) et un moyen (83a, 85a, 109a, 115a) sensible à une modification de position de la vanne pour inverser le sens de déplacement du piston (67a).
6. Système selon la revendication 5, dans lequel ledit moyen (83a, 85a, 109a, 115a) de modification de la position de la vanne (97a) inclut un moyen (115a) d'accouplement élastique servant à n-



trainner la vanne et le piston (67a).

7. Système selon la revendication 1, dans lequel le carter (27a) comprend un premier (201), un deuxième (33a) et un troisième (37a) passages, ledit piston (67a) comprend une première face à surface relativement grande dans ladite chambre d'entrée (69a), une deuxième face à surface plus petite dans la chambre de sortie (71a) et une face d'inversion dans la chambre d'inversion (73a), un moyen (89a) pour réaliser une communication entre ladite chambre d'entrée (69a) et ladite chambre de sortie (71a) pendant la course de retour, ledit carter (27a) comportant une deuxième cavité qui y est isolée de façon étanche de ladite chambre d'entrée (69a) et communique avec lesdits premier (201), deuxième (33a) et troisième (37a) passages, ladite vanne (97a) est dans ladite deuxième cavité et ménage une communication entre le premier (201) et le troisième (37a) passages et bloque une communication entre le deuxième (33a) et le troisième passages pendant la course de pompage et ménage une communication entre le premier (201) et le deuxième (33a) passages et bloque la communication entre le premier (201) et le troisième (37a) passages, pendant la course de retour, et un moyen (83a, 85a, 109a, 115a) sensible à un déplacement dudit piston (67a) pour mettre en oeuvre ladite vanne (97a).
8. Système selon la revendication 7, dans lequel ledit moyen (89a) servant à ménager une communication inclut une vanne de retenue (89a) portée par le piston (67a), et susceptible d'être ouverte pendant la course de retour afin de permettre à un fluide venant de la chambre d'entrée (69a) d'entrer dans la chambre de sortie (71a) afin de recharger ainsi en fluide la chambre de sortie.
9. Système selon l'une des revendications 7 ou 8, dans lequel ledit moyen (83a, 85a, 109a, 115a) de mise en oeuvre de la vanne (97a) inclut un moyen élastique (115a) d'accouplement de la vanne au piston (67a).

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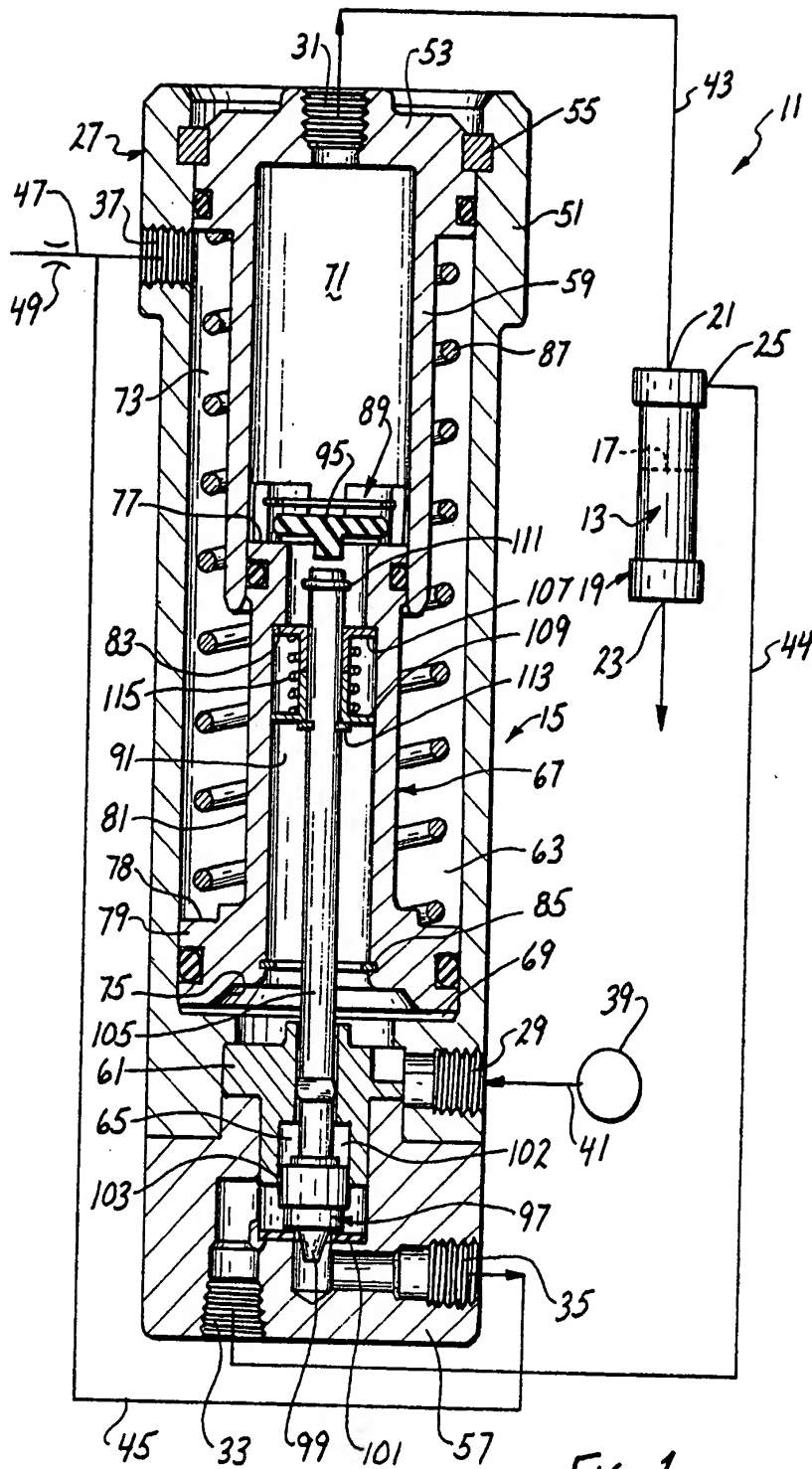
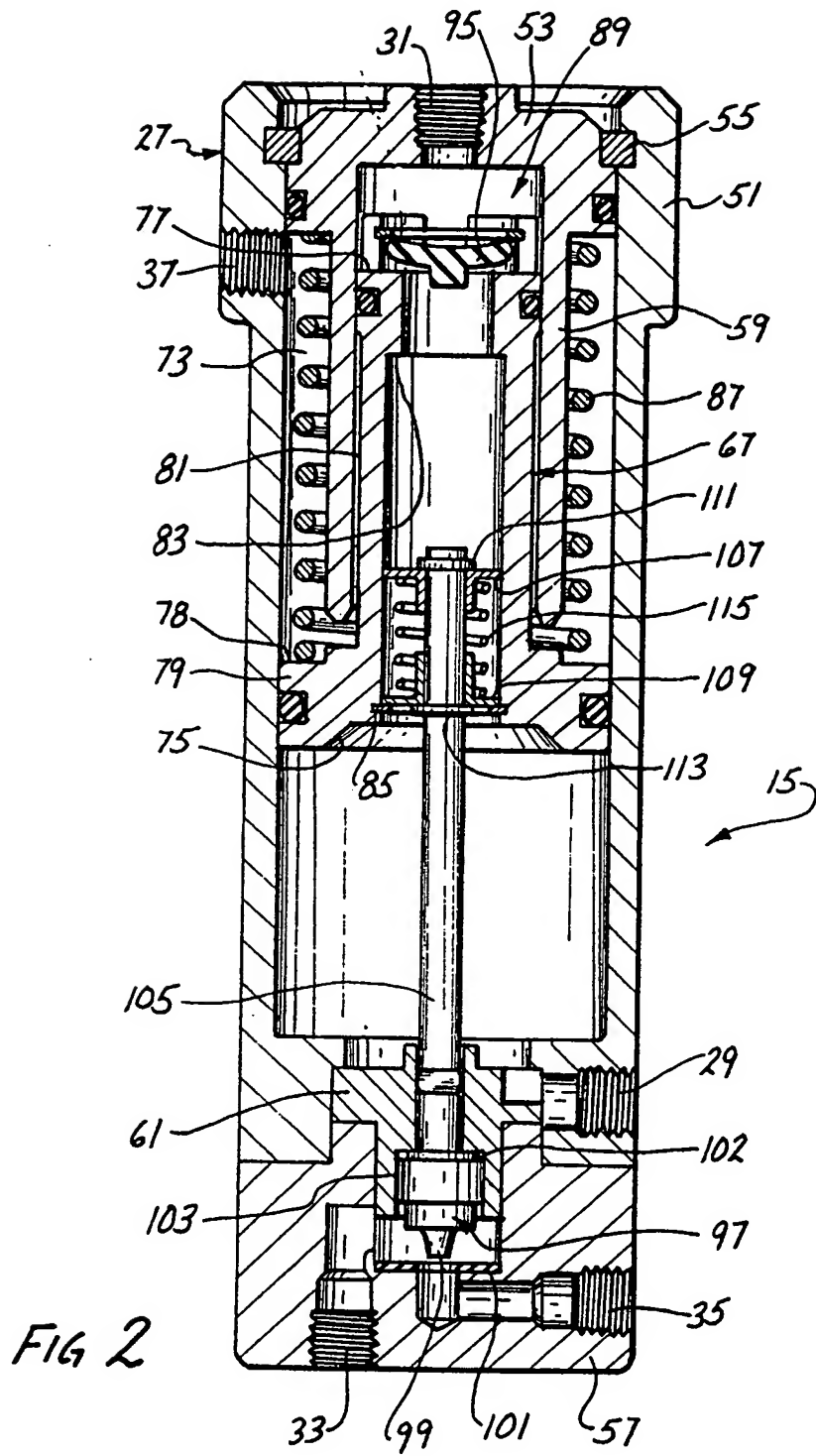
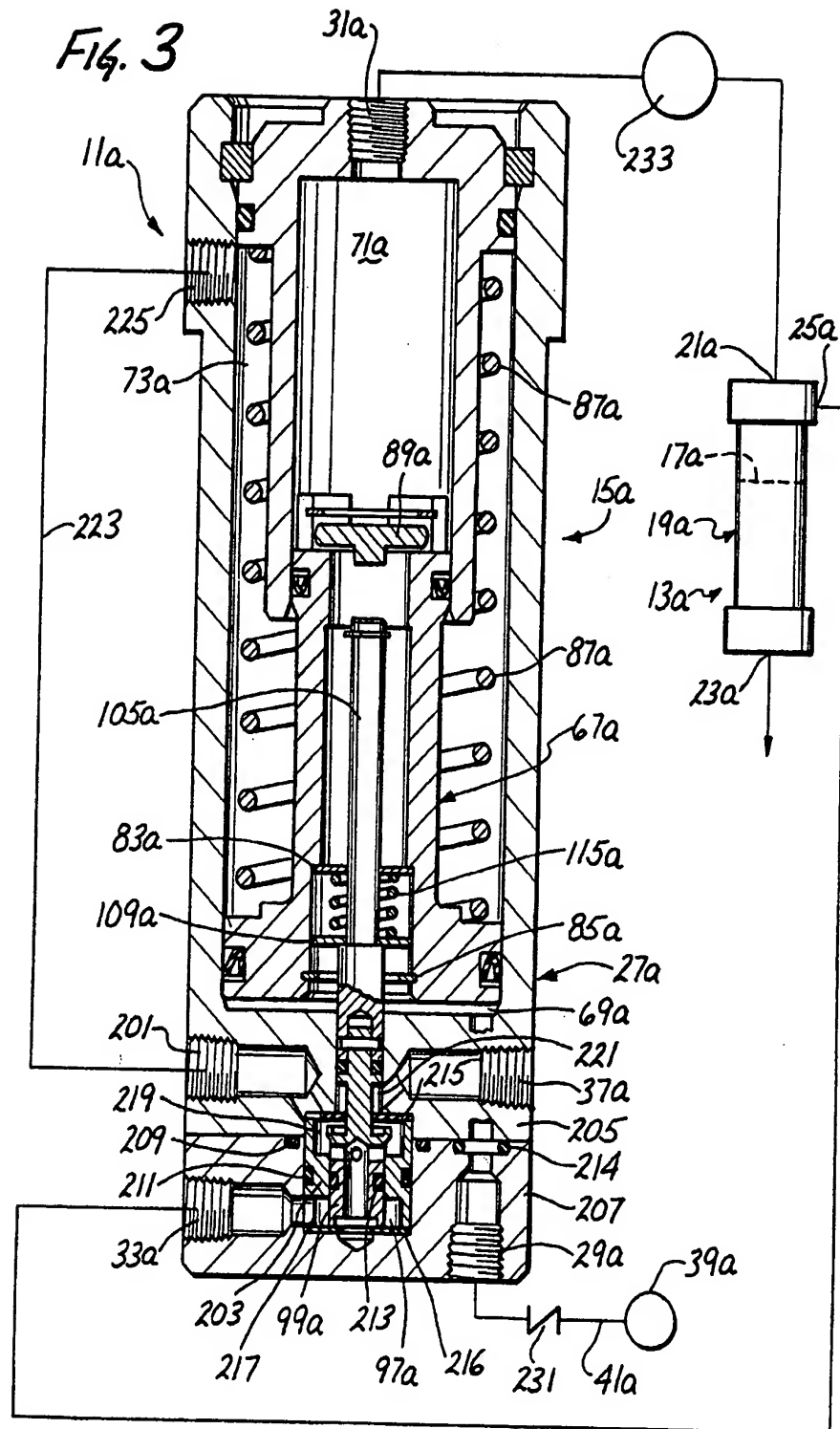
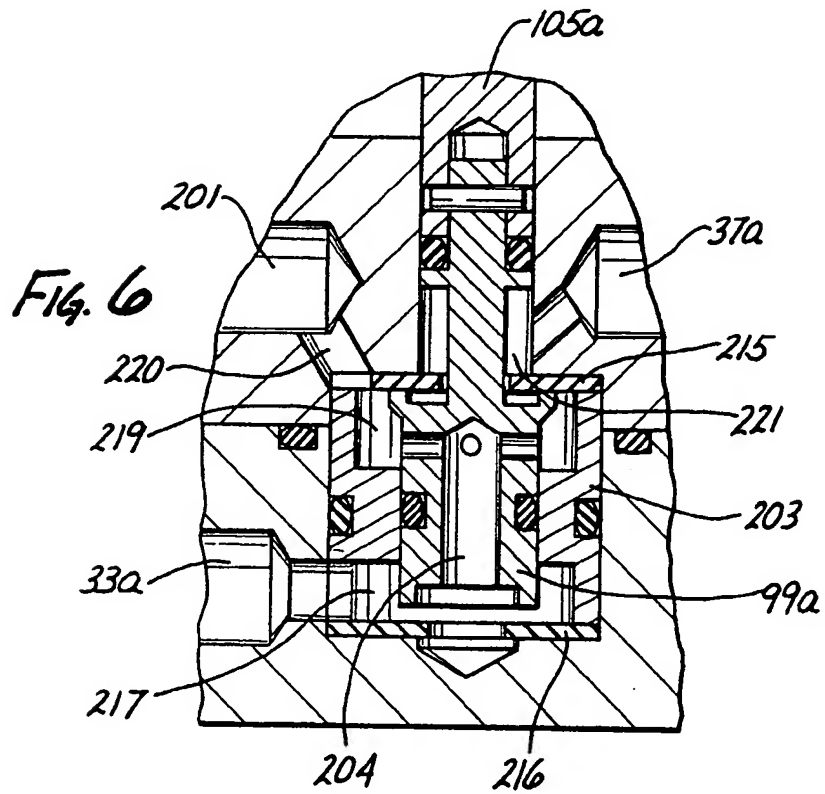
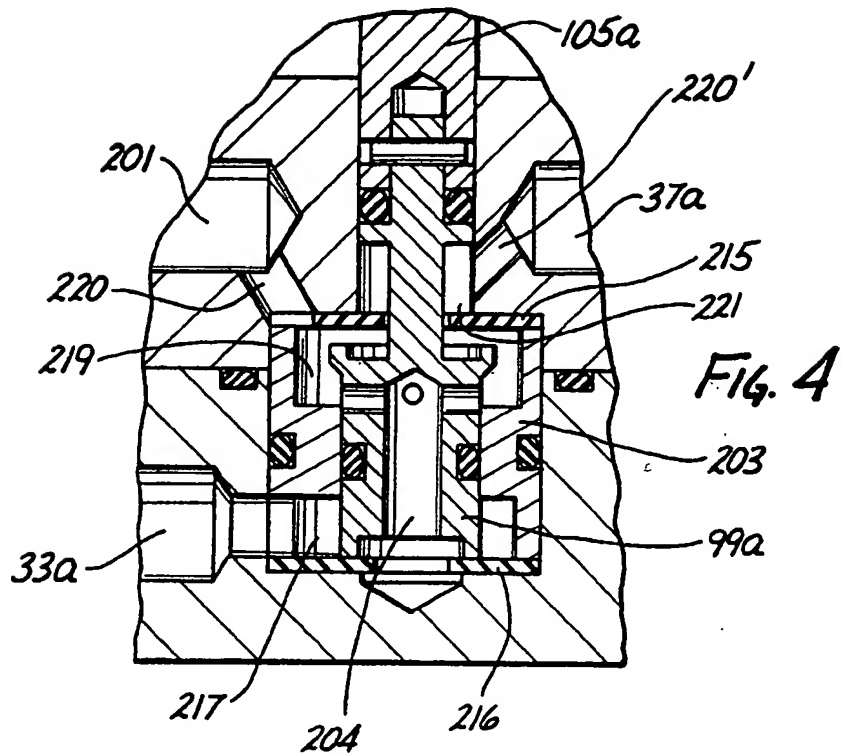


FIG 1







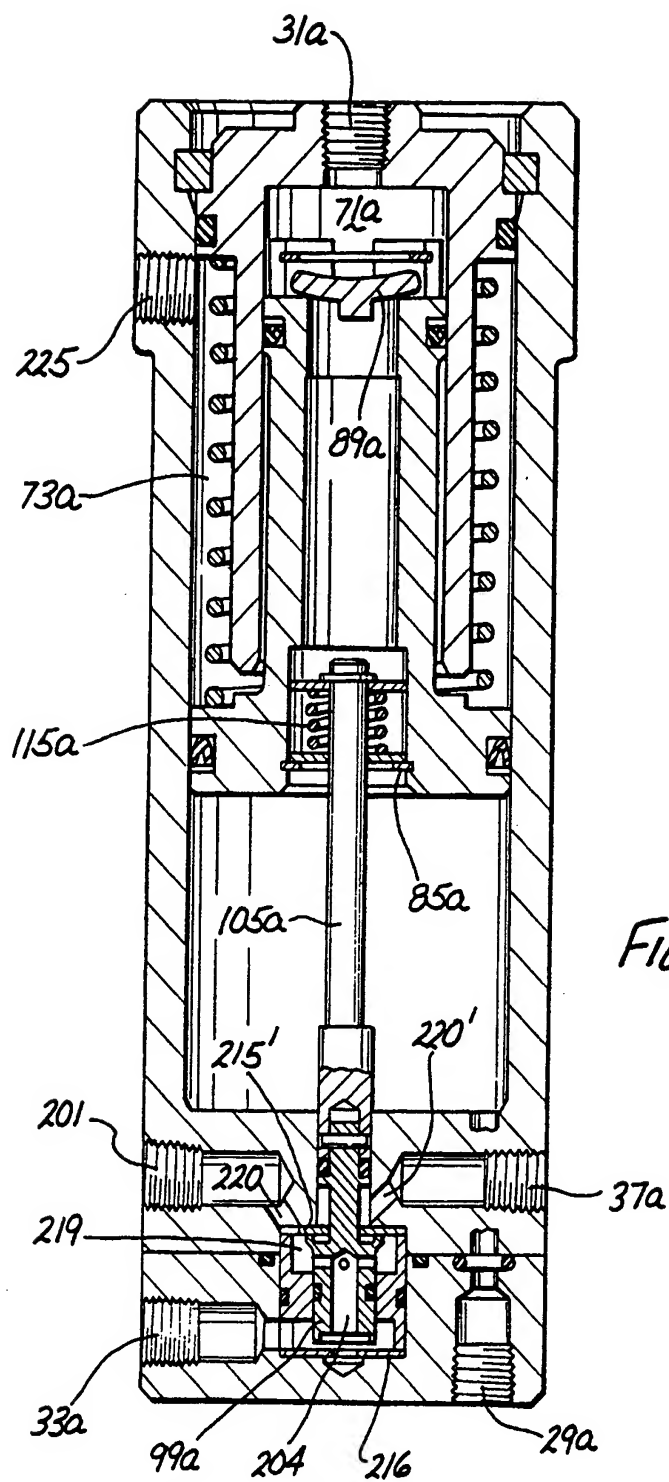


Fig 5